speed goes to zero. Where they are moving fast (it is fast moving boards that are more likely to injure) they don't settle. They thus settle in protected areas and blow clear of unprotected areas. Why would debris in a tornado act differently? At least this point should be discussed. An example that shows the weakness or even incorrectness of Eagleman's assumption is a house examined by the Weather Bureau disaster team on their second visit about 7 weeks after the tornado. The house was near the center of the path and was overturned, projecting into and filling the northeast corner of the basement and fully exposing the remainder of the basement. The basement was nearly full of light debris, although some could have been added in the cleanup after the storm. However, a neighbor explained to the team how he had helped five people out from under the debris in the southwest portion of the basement. The people came out uninjured.

The paper brings out some worthwhile points; however, these are not always explicitly stated. It does suggest that being in a basement is not enough for safety and that being surrounded by things like *filled* barrels or boxes, and covered by something solid like a table, would give considerable added protection against blowing debris. He also found that basement walls of stone or concrete block are relatively little protection (reinforced concrete is best) and that being near basement windows, like all others, is dangerous. His point about small interior rooms being relatively safer on the first floor is well worth knowing if you need protection and have no basement. It has been noted that such rooms in basements are also safer.

The Eagleman paper thus suggests that a long-standing rule appears to be without verification, but unfortunately verification with such limited and questionable data is inconclusive.

REFERENCE

1. J. R. Eagleman, "Tornado Damage Patterns in Topeka, Kansas, June 8, 1966," *Monthly Weather Review*, vol. 95, No. 6, June 1967, pp. 370–374.
2. S. D. Flora, *Tornadoes of the United States*, University of Oklahoma Press, Norman, 1953, 194 pp.
3. Environmental Science Services Administration, "Tornado Safety Rules," *ESSA/PI* 660030, May 1967, 1 p.
4. U.S. Weather Bureau, *Survey Team Report of Palm Sunday Tornadoes of 1965*, Washington, D.C., May 1965, 64 pp.

[*Received October 18, 1967*]

Reply

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My reply will be directed toward the comments of Mr. Hughes concerning the methods and statistics in the article on damage patterns in the Topeka Tornado [1]. I maintain that the statement "there was no statistical difference in the distribution of unsafe areas in different parts of the storm" is correct statistically. The reader may draw his own conclusions as to the number of observations involved. It should be pointed out in this connection, however, as it was in the paper that the effects of location of the dwelling within the storm path should be most pronounced on the first floor of structures since these are exposed to the full effects of the wind. Therefore the emphasis in the paper was placed on the first floor investigation with regard to the effects on the distribution of unsafe areas within dwellings caused by different locations within the storm path.

I believe that the assumption of a positive correlation between the amount of debris and the degree of unsafety in a dwelling is a very good one. This is undoubtedly better than checking on the location of injured persons since this would give valid information on the protection offered by various locations in a dwelling only if there were an equal number of persons located in each room of each dwelling during the tornado. This assumption of equal distribution of people is certainly not valid. The fact that some persons were not seriously injured even though they were in areas that had more debris does not diminish the results of the paper if the probability of injury remains greater for areas with more debris. This should certainly be the case if the debris were moving at a high speed during the tornado. Some of these effects were included when determining the unsafe areas during the investigation by noting the degree of scarring and puncturing of the floors or remaining walls of damaged structures.

REFERENCE

1. J. R. Eagleman, "Tornado Damage Patterns in Topeka, Kansas, June 8, 1966," *Monthly Weather Review*, vol. 95, No. 6, June 1967, pp. 370–374.

[*Received December 4, 1967*]

PICTURE OF THE MONTH

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An analysis of 328 tornado situations [1] indicates that certain elements—moisture, stability, freezing level, middle and high level winds, fronts, and squall lines—are necessary for the occurrence of severe storms. Some information about these elements can be extracted from satellite photographs.

On June 9, 1967, 89 occurrences of severe weather were reported. At 2030 GMT, ESSA 5 photographed the cloud patterns associated with some of this activity in the central and eastern United States (fig. 1). The accompanying surface analysis for 2100 GMT is shown in figure 2.

The edge of fair weather cumulus, formed as moist air from the Gulf of Mexico is heated over land, can be seen extending from southern Texas (c) northeastward into Missouri (d). A faint line of clouds, curving southward from a to b, marks the area of convergence along the

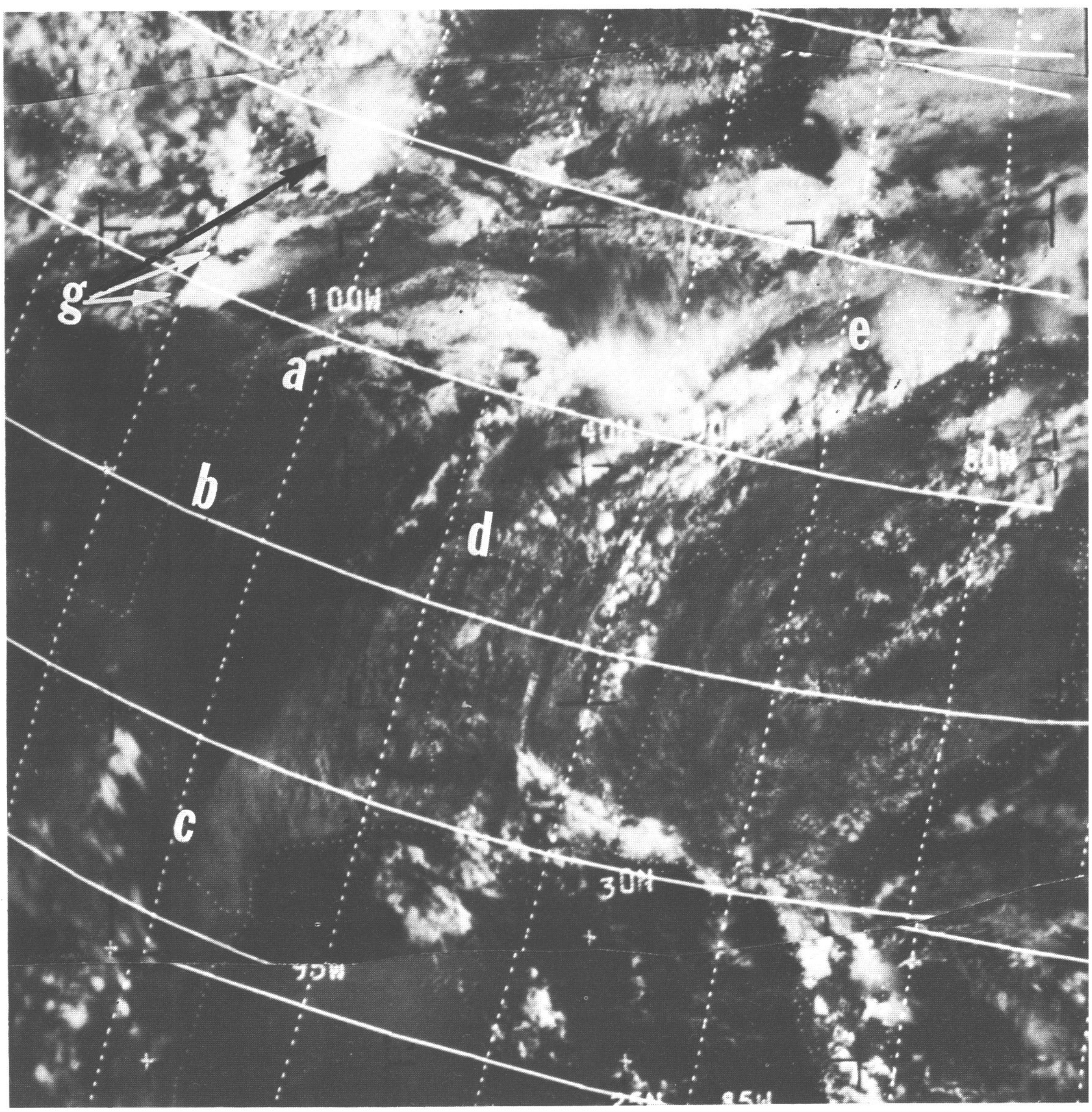

FIGURE 1.—ESSA 5, pass 638, June 9, 1967, 2038 GMT.

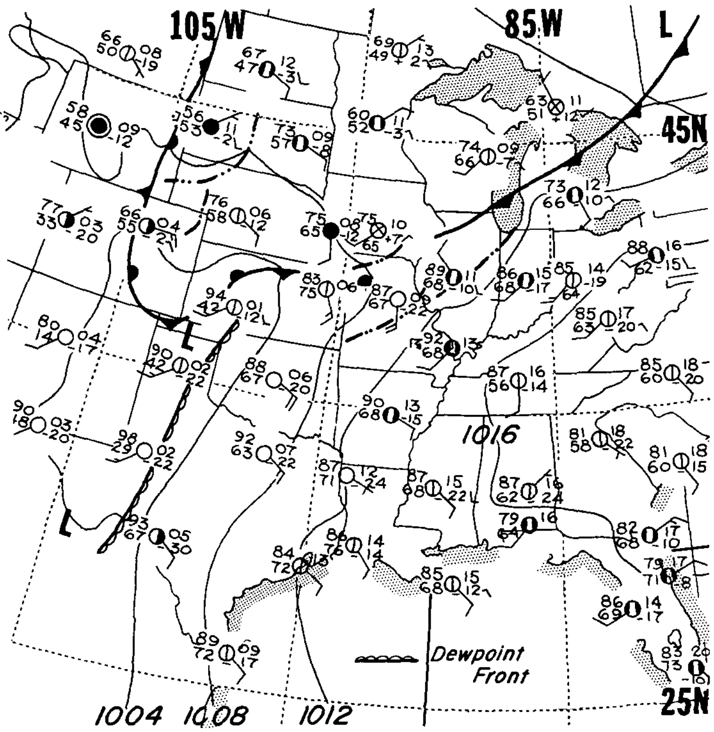

FIGURE 2.—Surface analysis, 2100 GMT June 9, 1967. Analysis prepared by the National Severe Storm Forecast Center, Kansas City, Mo.

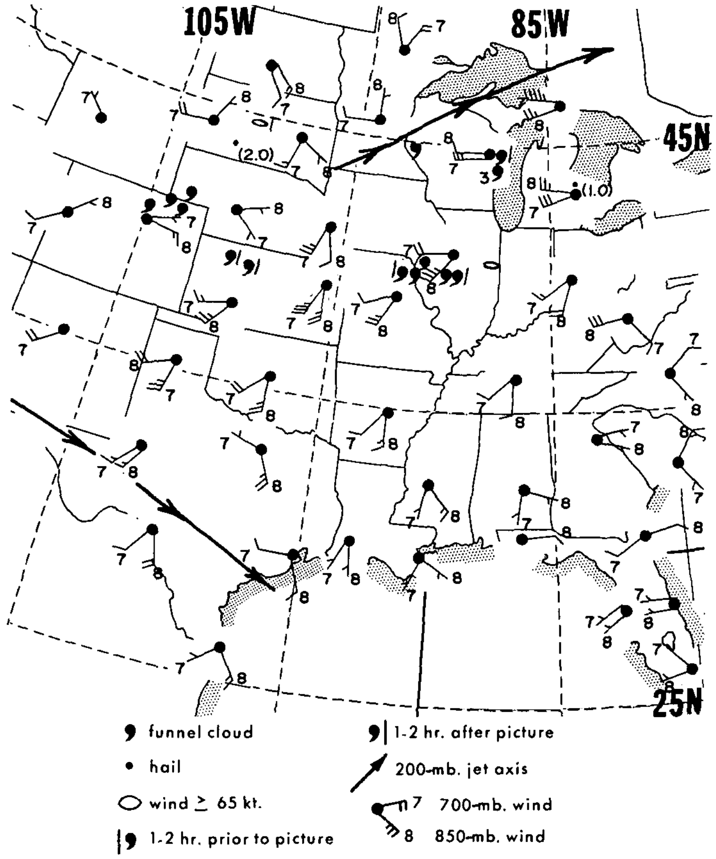

FIGURE 3.—850-mb., 700-mb. wind, 200-mb. jet axis for 0000 GMT, June 10, 1967, and reported severe weather.

northern portion of the dew point front. Warm, dry, clear air lies to the west of this line.

Figure 3 shows the 850-mb. and 700-mb. winds and the severe weather reported within 2 hr. of the satellite photograph. Three large cumulonimbus clusters with tops at 25,000–30,000 ft. were reported in Radar Summary 2045 GMT, July 9, 1967. These clusters can be seen at g in the upper left hand corner in figure 1. A long cirrus plume from the southern cluster over Denver indicates strong southwesterly flow at the cirrus level. Four funnel clouds were reported at this point within an hour of the picture. The central cluster of thunderstorms was part of a squall line which extended northeastward into Nebraska. The northernmost cluster, centered in South Dakota, with cirrus extending to the north, produced 2-in. hail and gusty winds in that area.

Farther east, a squall line (d, e) with cloud tops to 43,000 ft., stretches from central Missouri into Michigan. The cloud lines ahead of and parallel to d and e suggest two additional squall lines not apparent in the data (fig. 2). Another large thunderstorm cluster is located at 41°N., 91°W. Orientation of the cirrus blowoffs indicates that southeasterly flow was present above the west and southwest winds reported at 700 and 850 mb. The combination of moisture, instability, and turning of the winds resulted in numerous occurrences of severe weather throughout the day.

Through detailed examination of satellite photographs, moisture and stability conditions can be inferred from the type and size of clouds. The organization, distribution, and cirrus shear of convective cloud elements can be used to determine squall line and frontal positions and high level wind directions and speeds.

REFERENCE

1. R. C. Miller, "Semi-Objective Evaluation of the Relative Importance of Parameters Favoring Production of Severe Local Storms," *Proceedings of the American Meteorological Society Conference on Severe Local Storms, St. Louis, Missouri, October 19–20, 1967.*